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Suzuki

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(54) **GENERATING A DISPLAY LIST FOR PROCESSING BY A RENDERING UNIT**

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G06K 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G06K 15/4005*** (2013.01); ***H04N 1/21*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 3/1217; G06F 3/1298; H04N 1/21
USPC 358/1.16
See application file for complete search history.

(56) **References Cited**

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(57) **ABSTRACT**

A display list generation apparatus includes an interpretation unit configured to interpret page description language (PDL) data and store an interpretation result of the PDL data in a first storage unit, a copying unit configured to copy the interpretation result stored in the first storage unit, in a second storage unit, and a generation unit configured to generate a display list from the interpretation result stored in the first storage unit in a case where a data size of the interpretation result exceeds a predetermined threshold and generate a display list from the copy of the interpretation result stored in the second storage unit in a case where the data size of the interpretation result does not exceed the predetermined threshold.

18 Claims, 9 Drawing Sheets

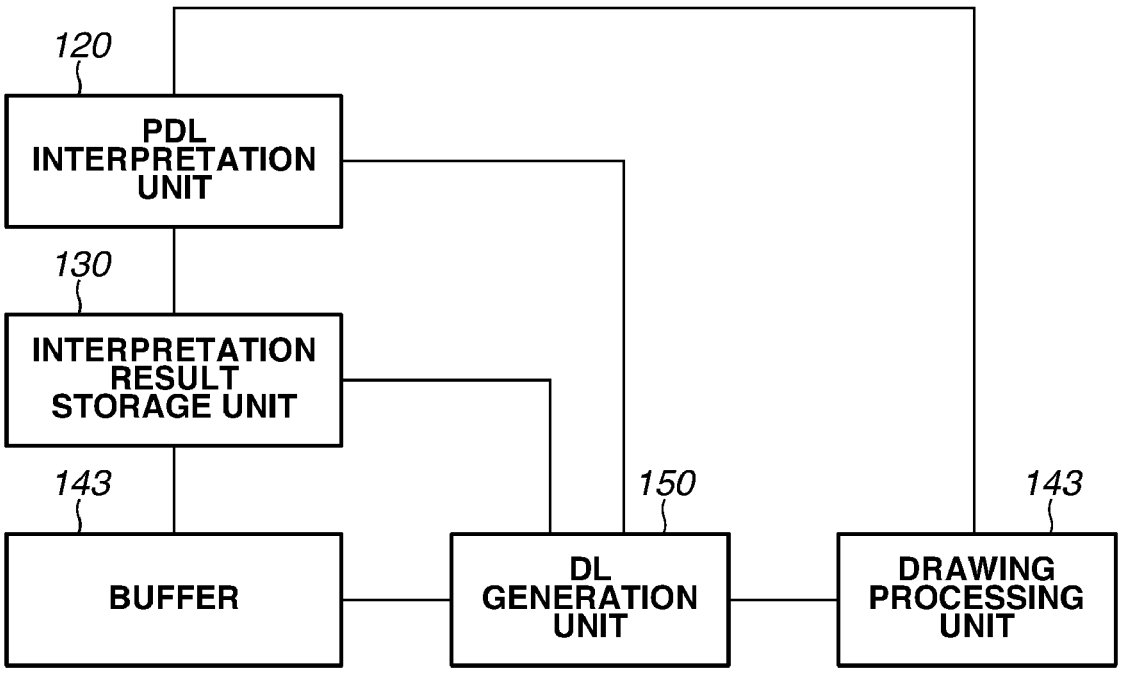


FIG.1

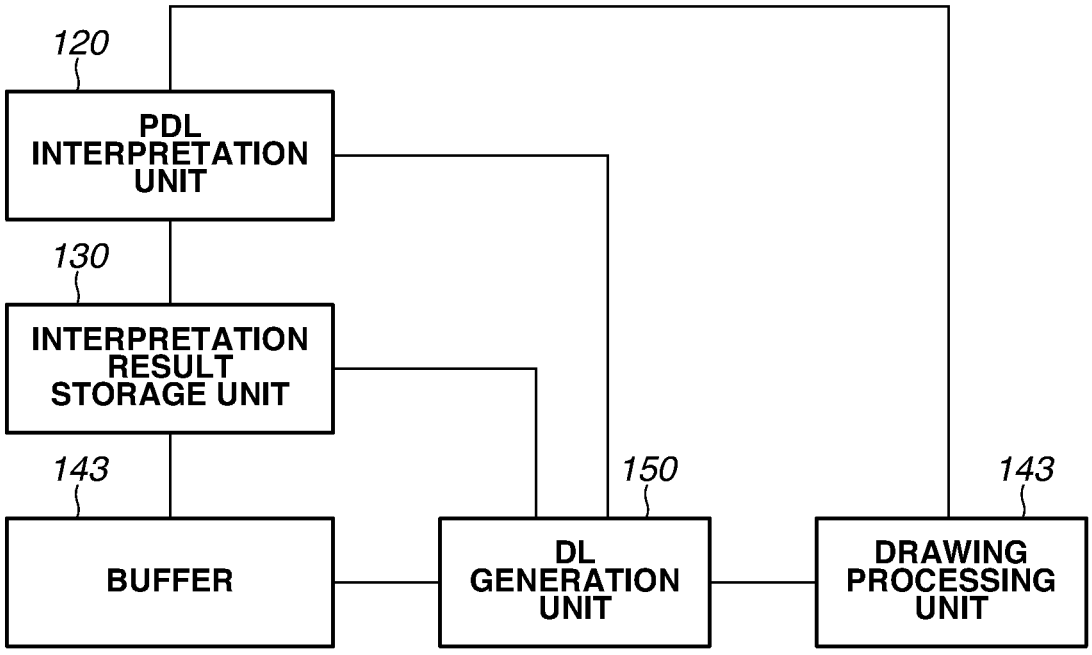

120
PDL INTERPRETATION UNIT
130
INTERPRETATION RESULT STORAGE UNIT
143
BUFFER
150
DL GENERATION UNIT
143
DRAWING PROCESSING UNIT

FIG.2A

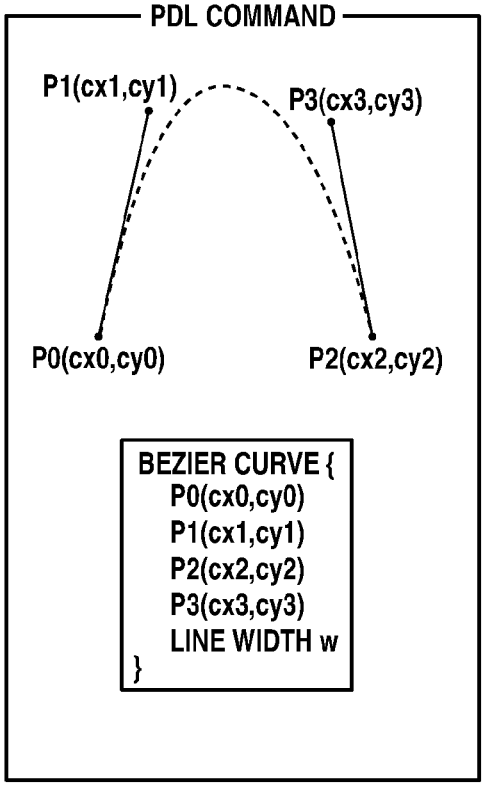


FIG.2B

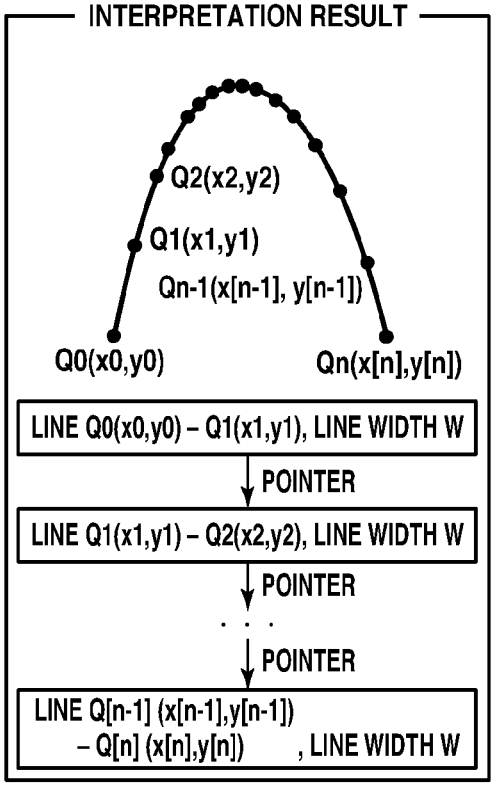


FIG.2C

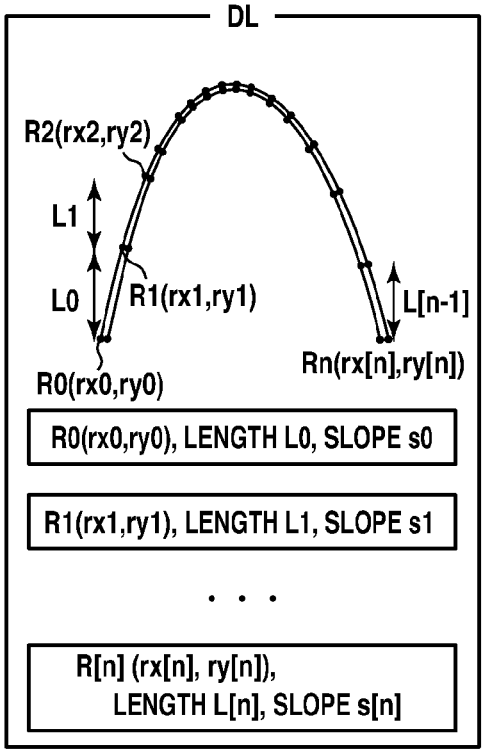


FIG.3

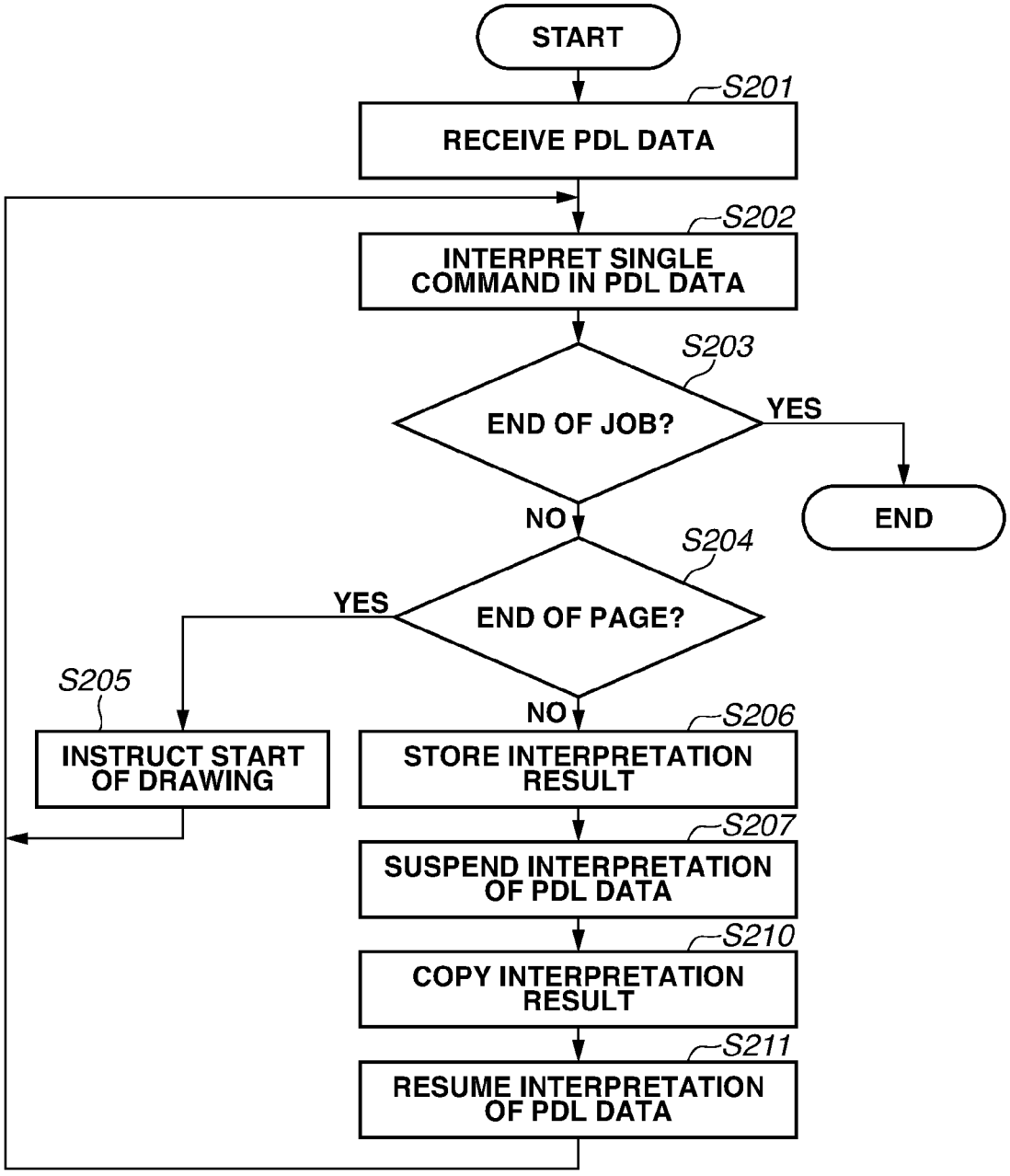

START
S201
RECEIVE PDL DATA
S202
INTERPRET SINGLE COMMAND IN PDL DATA
S203
END OF JOB?
YES
END
NO
S204
END OF PAGE?
YES
S205
INSTRUCT START OF DRAWING
NO
S206
STORE INTERPRETATION RESULT
S207
SUSPEND INTERPRETATION OF PDL DATA
S210
COPY INTERPRETATION RESULT
S211
RESUME INTERPRETATION OF PDL DATA

FIG.4

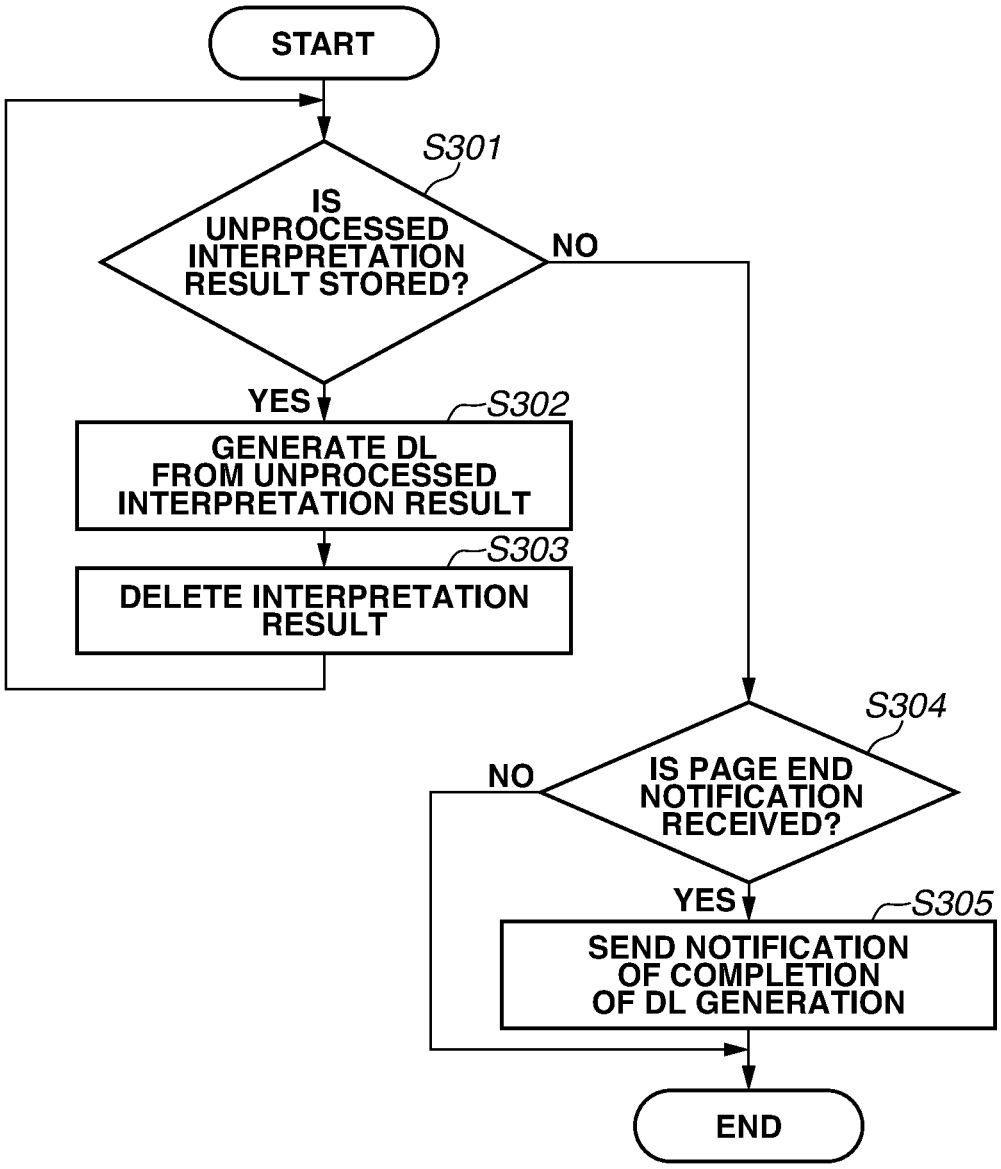

START
S301
IS UNPROCESSED INTERPRETATION RESULT STORED?
NO
YES
S302
GENERATE DL FROM UNPROCESSED INTERPRETATION RESULT
S303
DELETE INTERPRETATION RESULT
S304
IS PAGE END NOTIFICATION RECEIVED?
NO
YES
S305
SEND NOTIFICATION OF COMPLETION OF DL GENERATION
END

FIG.5

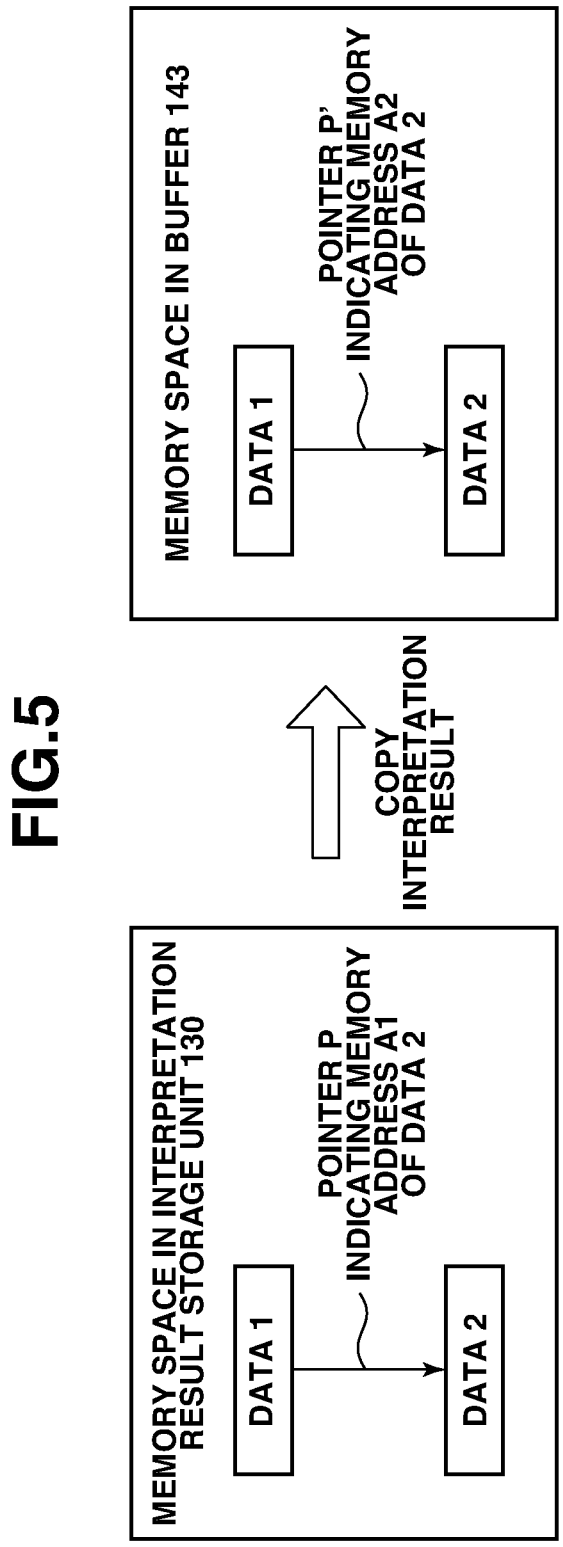

MEMORY SPACE IN INTERPRETATION RESULT STORAGE UNIT 130
DATA 1
POINTER P INDICATING MEMORY ADDRESS A1 OF DATA 2
DATA 2
COPY INTERPRETATION RESULT
MEMORY SPACE IN BUFFER 143
DATA 1
POINTER P' INDICATING MEMORY ADDRESS A2 OF DATA 2
DATA 2

FIG.6

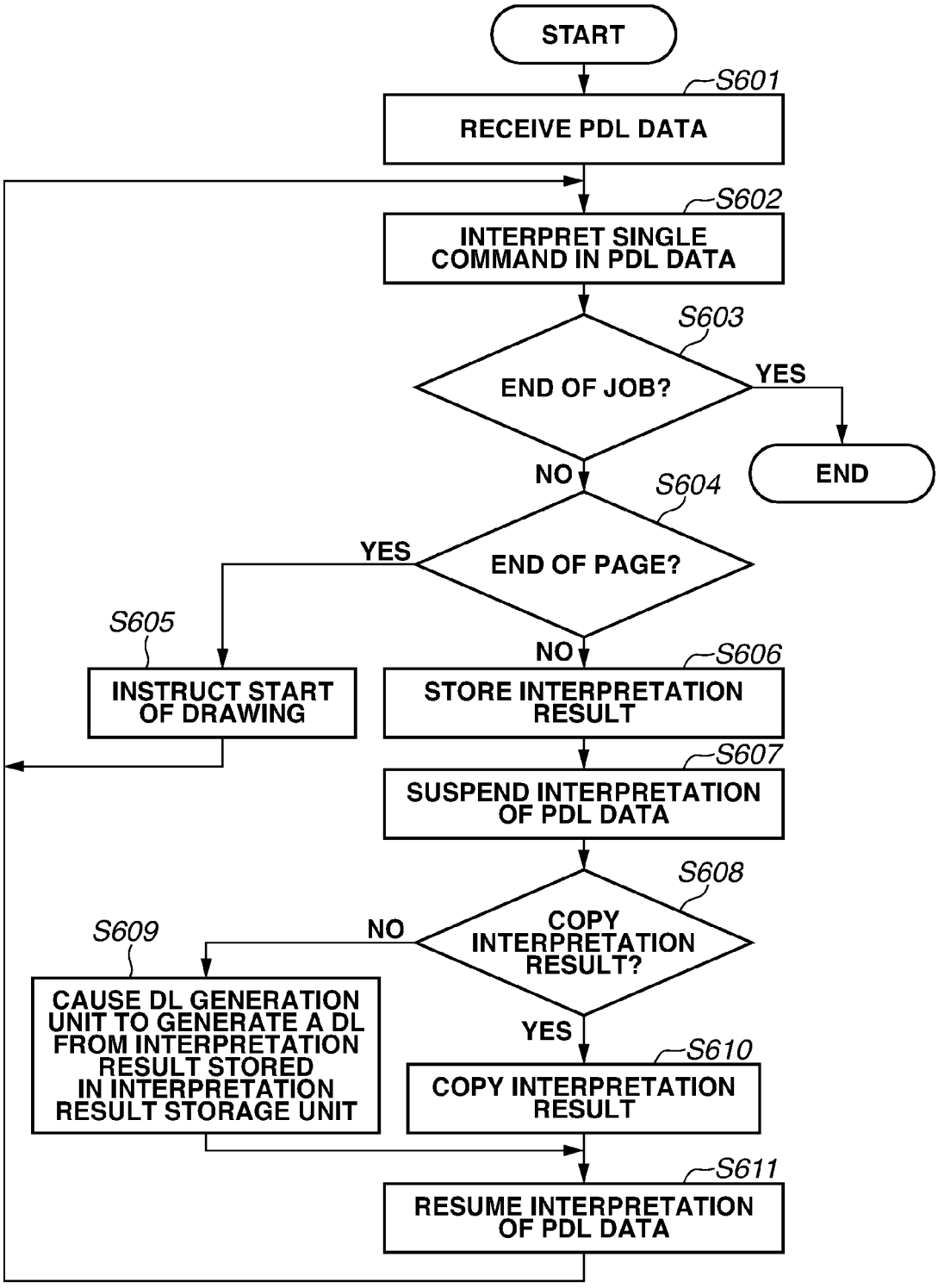

START
S601
RECEIVE PDL DATA
S602
INTERPRET SINGLE COMMAND IN PDL DATA
S603
END OF JOB?
YES
END
NO
S604
END OF PAGE?
YES
S605
INSTRUCT START OF DRAWING
NO
S606
STORE INTERPRETATION RESULT
S607
SUSPEND INTERPRETATION OF PDL DATA
S608
COPY INTERPRETATION RESULT?
NO
S609
CAUSE DL GENERATION UNIT TO GENERATE A DL FROM INTERPRETATION RESULT STORED IN INTERPRETATION RESULT STORAGE UNIT
YES
S610
COPY INTERPRETATION RESULT
S611
RESUME INTERPRETATION OF PDL DATA

FIG.7

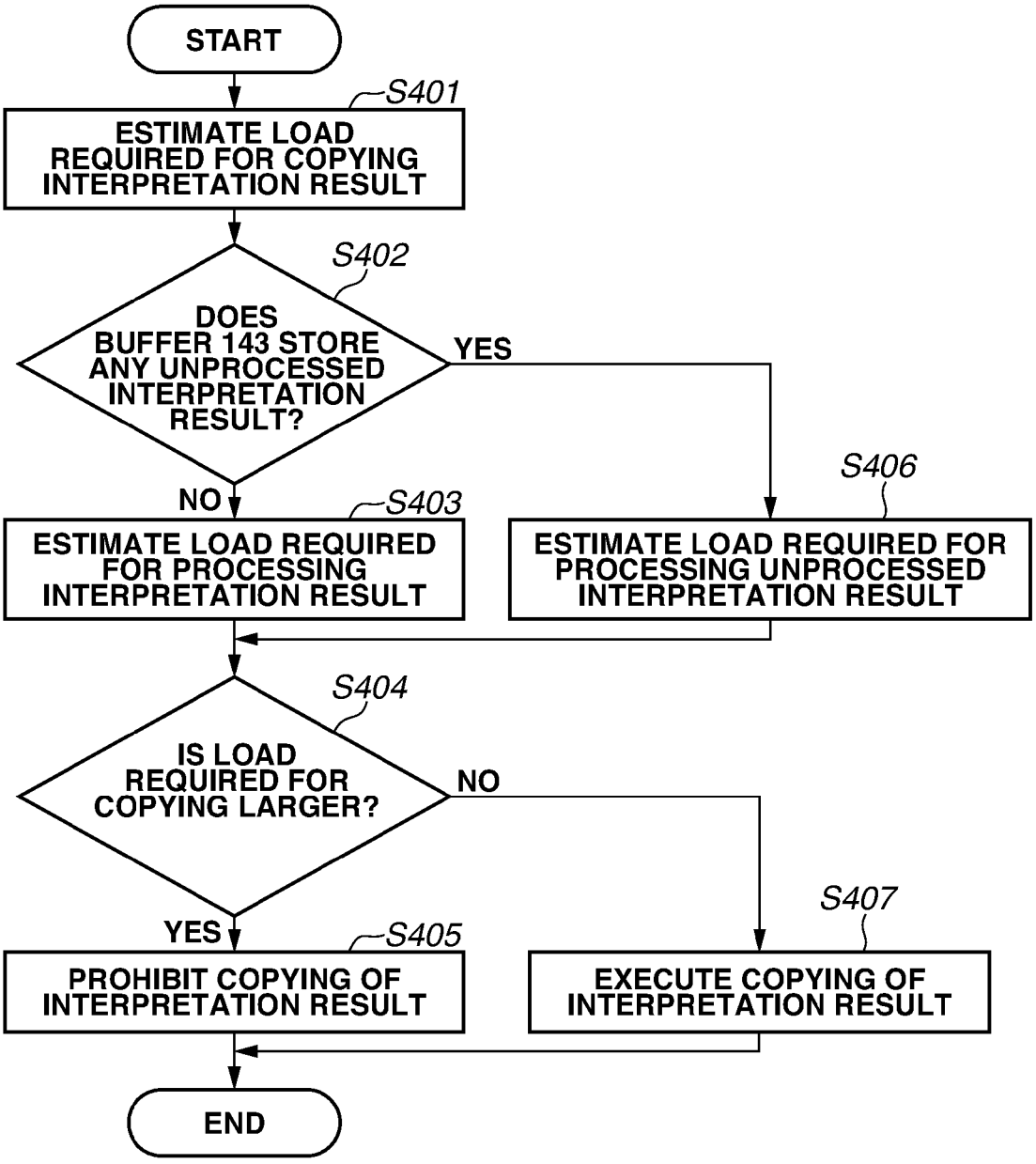

START
S401
ESTIMATE LOAD REQUIRED FOR COPYING INTERPRETATION RESULT
S402
DOES BUFFER 143 STORE ANY UNPROCESSED INTERPRETATION RESULT?
YES
NO
S403
ESTIMATE LOAD REQUIRED FOR PROCESSING INTERPRETATION RESULT
S406
ESTIMATE LOAD REQUIRED FOR PROCESSING UNPROCESSED INTERPRETATION RESULT
S404
IS LOAD REQUIRED FOR COPYING LARGER?
NO
YES
S405
PROHIBIT COPYING OF INTERPRETATION RESULT
S407
EXECUTE COPYING OF INTERPRETATION RESULT
END

FIG.8A

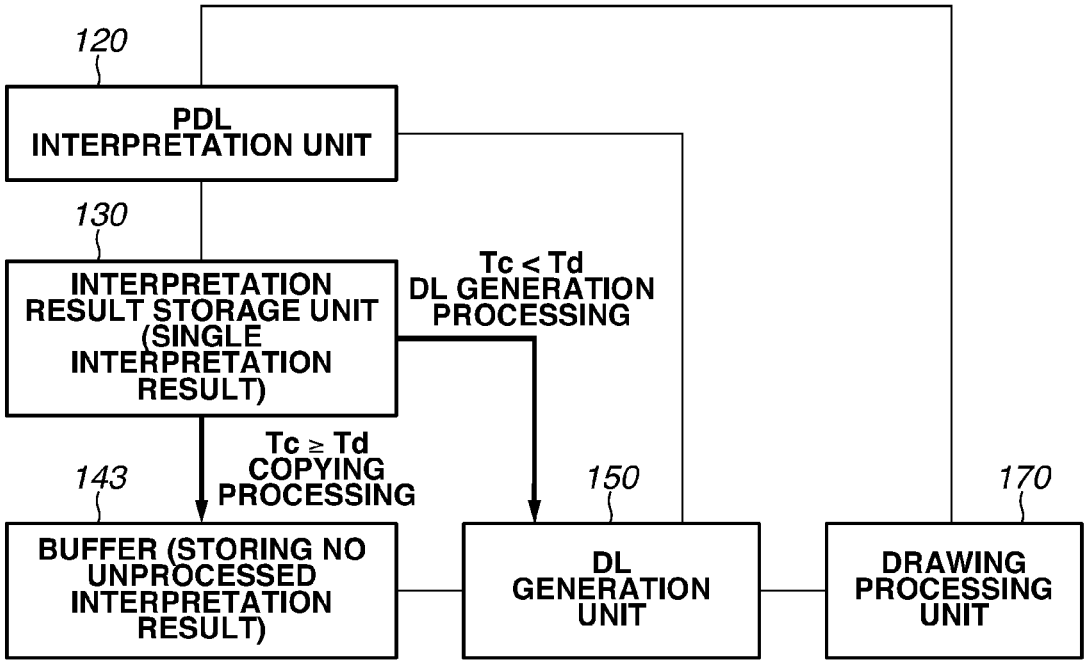

120
PDL INTERPRETATION UNIT
130
INTERPRETATION RESULT STORAGE UNIT (SINGLE INTERPRETATION RESULT)
Tc < Td DL GENERATION PROCESSING
Tc ≥ Td COPYING PROCESSING
143
BUFFER (STORING NO UNPROCESSED INTERPRETATION RESULT)
150
DL GENERATION UNIT
170
DRAWING PROCESSING UNIT

FIG.8B

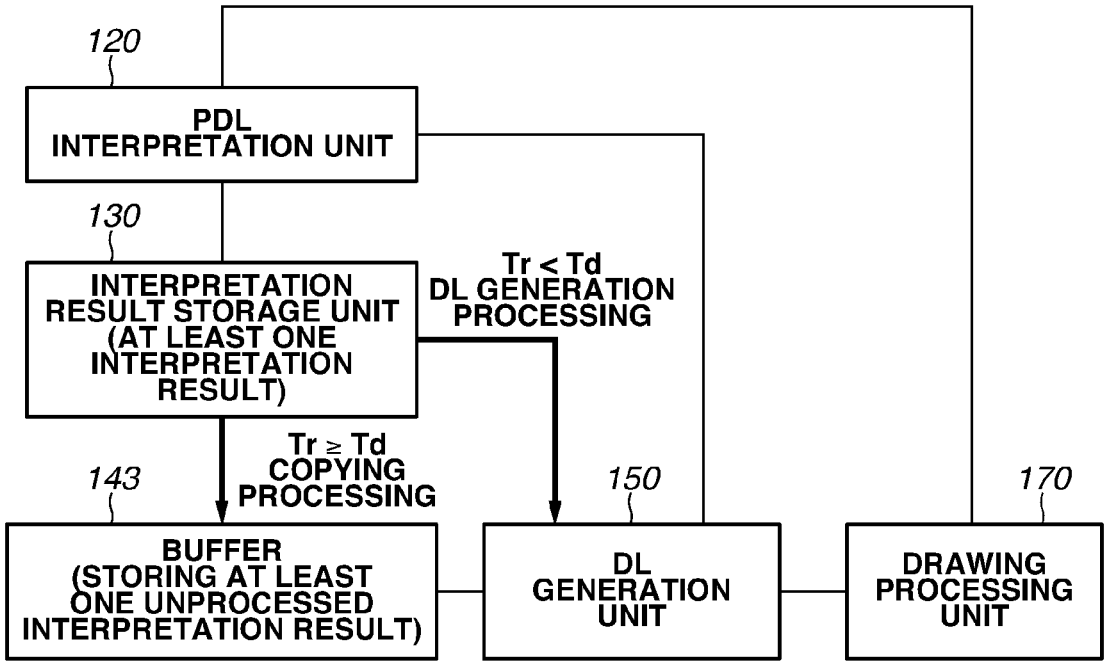
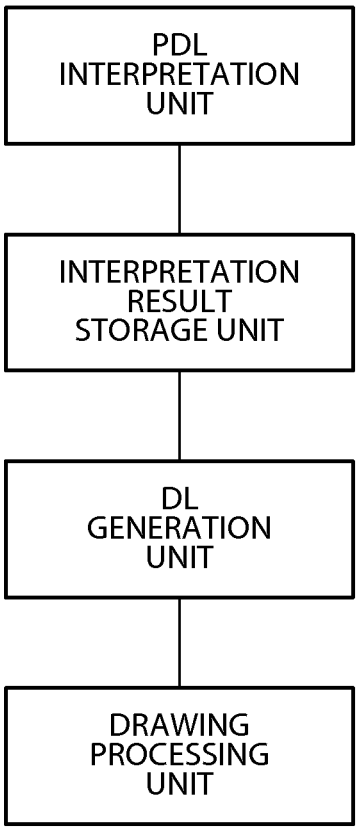

120
PDL INTERPRETATION UNIT
130
INTERPRETATION RESULT STORAGE UNIT (AT LEAST ONE INTERPRETATION RESULT)
Tr < Td DL GENERATION PROCESSING
Tr ≥ Td COPYING PROCESSING
143
BUFFER (STORING AT LEAST ONE UNPROCESSED INTERPRETATION RESULT)
150
DL GENERATION UNIT
170
DRAWING PROCESSING UNIT

FIG.9


PDL INTERPRETATION UNIT
INTERPRETATION RESULT STORAGE UNIT
DL GENERATION UNIT
DRAWING PROCESSING UNIT

GENERATING A DISPLAY LIST FOR PROCESSING BY A RENDERING UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a technique for generating a display list.

2. Description of the Related Art

Japanese Patent Application Laid-Open No. 2012-86450 discusses an apparatus for generating from page description language (PDL) data intermediate data called a display list (DL) that can be processed by a rendering unit. In this apparatus, a PDL interpretation unit interprets PDL data and a DL generation unit generates a DL from a result of the interpretation. Next, the rendering unit executes a rendering operation on the basis of the generated DL to generate a bitmap image.

Hereinafter, a case as illustrated in FIG. **9** where an interpretation result storage unit used for sending a PDL data interpretation result to a DL generation unit has a very small storage capacity will be considered. For example, an interpretation result storage unit will be considered which may have a storage capacity that can only store the interpretation result of one PDL command included in PDL data.

In this case, it is required that, while the DL generation unit is accessing the interpretation result storage unit and is generating a DL from the interpretation result of a single command, the content of the interpretation result is not changed. Thus, while the DL generation unit is accessing the interpretation result storage unit, the PDL interpretation unit does not access the interpretation result storage unit. As a result, while the DL generation unit is accessing the interpretation result storage unit, the PDL interpretation unit does not access this interpretation result storage unit. More specifically, the PDL interpretation unit cannot overwrite the current interpretation result with an interpretation result of the next PDL command in the interpretation result storage unit. Namely, since the PDL interpretation unit and the DL generation unit execute the processing in synchronization with each other, delay in the processing by the DL generation unit directly results in delay in the processing by the PDL interpretation unit.

SUMMARY OF THE INVENTION

A display list generation apparatus includes an interpretation unit configured to interpret page description language (PDL) data and store an interpretation result of the PDL data in a first storage unit, a copying unit configured to copy the interpretation result stored in the first storage unit, in a second storage unit, and a generation unit configured to generate a display list from the interpretation result stored in the first storage unit in a case where a data size of the interpretation result exceeds a predetermined threshold and generate a display list from the copy of the interpretation result stored in the second storage unit in a case where the data size of the interpretation result does not exceed the predetermined threshold.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating a hardware configuration of a printer controller.

FIGS. **2**A, **2**B, and **2**C illustrate a PDL command, an interpretation result, and a DL, respectively.

FIG. **3** is a flowchart illustrating PDL data interpretation processing according to a first exemplary embodiment.

FIG. **4** is a flowchart illustrating DL generation processing.

FIG. **5** illustrates interpretation result copy processing.

FIG. **6** is a flowchart illustrating PDL data interpretation processing according to a second exemplary embodiment.

FIG. **7** is a flowchart illustrating processing for determining whether to execute interpretation result copy processing.

FIGS. **8**A and **8**B illustrate operations of a printer controller according to a second exemplary embodiment.

FIG. **9** illustrates processing for generating a DL from PDL data.

DESCRIPTION OF THE EMBODIMENTS

Various exemplary embodiments, features, and aspects of the invention will be described in detail below with reference to the drawings.

Next, exemplary embodiments of the present invention will be described with reference to the drawings.

<Configuration of Printer Controller>

FIG. **1** illustrates a hardware configuration of a printer controller in a printing apparatus according to a first exemplary embodiment. In this printer controller, an interpretation result storage unit **130** is connected to a buffer **143** and stores a copy of a PDL data interpretation result stored by a PDL interpretation unit **120** in the buffer **143**. With this configuration, even when a DL generation unit **150** is generating a DL from the copy of the interpretation result stored in the buffer **143**, the PDL interpretation unit **120** can store a PDL data interpretation result in the interpretation result storage unit **130**. Next, this operation will be described in detail.

The printing apparatus may be a single function printer (SFP) or a multi function peripheral (MFP). First, processing of this printer controller will be summarized. The printer controller according to the present exemplary embodiment can also serve as a display list generation apparatus, as will become apparent below.

Each block illustrated in FIG. **1** represents hardware of a unit and each line that connects blocks represents a signal line connecting each unit. Each unit exchanges information with other units via these signal lines.

The PDL interpretation unit **120** receives PDL data in a plurality of types of PDL formats (for example, Printer Command Language (PCL) (registered trademark) or PostScript (registered trademark)) from an external apparatus via a network interface I/F (not illustrated). The PDL interpretation unit **120** executes processing of a flowchart illustrated in FIG. **3**. Namely, the PDL interpretation unit **120** can interprets PDL data in a plurality of PDL formats.

The interpretation result storage unit **130** includes a volatile memory having a storage area for storing an interpretation result of a command (PDL command) included in PDL data interpreted by the PDL interpretation unit **120**. The interpretation result storage unit **130** copies this interpretation result in the buffer **143**. The storage capacity of the interpretation result storage unit **130** according to the present exemplary embodiment corresponds to the maximum value (fixed size) of the amount of the interpretation result of a single PDL command. This interpretation result storage unit **130** stores the interpretation result of a single PDL command, not the interpretation results of two or more PDL commands.

The buffer **143** includes a volatile memory having a storage area for storing a copy of the interpretation result stored in the interpretation result storage unit **130**. The buffer **143** according to the present exemplary embodiment is a ring buffer. The

storage capacity of the buffer **143** has a fixed size larger than that of the interpretation result storage unit **130**.

The DL generation unit **150** executes processing of a flowchart illustrated in FIG. **4**.

When a rendering unit **170** is instructed to start rendering processing by the PDL interpretation unit **120** and is notified of completion of generation of a display list (DL) of one page by the DL generation unit **150**, the rendering unit **170** receives the DL of one page from the DL generation unit **150**. Next, the rendering unit **170** generates a bitmap image from the DL. Processing for generating a bitmap image from a DL is referred to as rendering processing.

The bitmap image generated by the rendering processing is transmitted to a printer engine (not illustrated) included in the printing apparatus according to the present exemplary embodiment and is printed on a sheet recording medium such as paper by the printer engine. Subsequently, the printed recording medium is discharged as a print product to the outside of the printing apparatus. As this printer engine, an arbitrary type of printer engine may be used such as an electrophotographic printer engine or an ink-jet printer engine.

<PDL Command, Interpretation Result, DL>

Generally, the PDL data includes a plurality of PDL commands. The PDL command is a command specifying the end of a print job, a command specifying a page break, or a command (rendering command) specifying rendering of an object.

FIGS. **2**A to **2**C conceptually illustrate a PDL command (a rendering command), an interpretation result of the PDL command, and a DL generated by the interpretation result, respectively. In FIG. **2**A, a rendering command for a Bezier curve is illustrated. Differences among these PDL command, interpretation result, and DL will be described with reference to the examples in FIGS. **2**A to **2**C.

The PDL command (rendering command) for rendering a Bezier curve indicated by a dashed line in FIG. **2**A specifies four control points (P0, P1, P2, P3) of the Bezier curve, a line width (w) of the Bezier curve, and a line color of the Bezier curve. Different rendering command formats of different PDL types (for example, PCL (registered trademark) or PostScript (registered trademark)), can be used to obtain the same rendering result.

The PDL interpretation unit **120** interprets this rendering command and approximately represents the Bezier curve indicated by the dashed line by using a plurality of lines. Each of these lines is defined by coordinates of both ends thereof. For example, as illustrated in FIG. **2**B, line Q0-Q1 is a line that connects point Q0 represented by coordinates (x0, y0) and point Q1 represented by coordinates (x1, y1) and that has the line width (w).

In addition, data (interpretation result) representing these lines is stored in the interpretation result storage unit **130**. Connected lines are linked to each other by pointers and have a link configuration. For example, the data representing line Q0-Q1 stored in the interpretation result storage unit **130** has a pointer indicating a memory address in the interpretation result storage unit **130** in which data representing line Q1-Q2 is stored. Each data representing a corresponding line has information representing the width of and the color of the line (color of the Bezier curve). This interpretation result is data in unique format that does not depend on a PDL type in a case where the same rendering result can be obtained.

The DL generation unit **150** generates a DL from an interpretation result, which is data representing a plurality of lines having a line width. In this example, the DL is formed by logical line objects, each of which is associated with a color and does not have a line width. In this example, more specifically, a single line in an interpretation result that is painted in a line color and that has a line width is locally a rectangle that is painted in a line color. In this DL, each of the four sides forming the contour of the rectangle is treated as a single object. For example, in the DL illustrated in FIG. **2**C, line R0-R1, which is the left side of line Q0-Q1 having line width w in the interpretation result, is treated as a single object with which a line color is associated and that does not have a line width. This single object in the DL is defined by the start point of the line, the height (length) in y direction of the line, the slope of the line, and the color associated with the line. For example, in the case of line R0-R1, information representing start point R1 of the line, height L0 in y direction, slope s0 of the line, and the color of the line (color of the Bezier curve) is included in the DL.

Thus, a DL is intermediate data in a format in which an object (for example, a Bezier curve) specified by a single rendering command (for example, a rendering command for the Bezier curve) is represented by one or more simple objects each of which is a unit that can be processed by the rendering unit **170**.

By rendering objects (for example, lines) included in this DL, the rendering unit **170** generates a bitmap image of the single object (for example, the Bezier curve) specified by the rendering command. For example, this bitmap image is an image formed by painting the inside of the contour indicated by the DL in FIG. **2**C in the color of the Bezier curve.

As described above, first, an interpretation result is generated from a PDL command, and next, a DL is generated from the interpretation result. Finally, a bitmap image is generated from the DL. The interpretation result generated from the PDL command is data in a common format that does not depend on the type of PDL data (for example, PCL (registered trademark), PostScript (registered trademark), etc.). Since common data format is used, the DL generation unit **150** can easily generate a DL even if different types of PDL command are used. To generate such common format data from a PDL command, the PDL interpretation unit **120** includes a plurality of circuits corresponding to PDL data types.

<Operation of Printer Controller>

Next, operations of the printer controller according to the first exemplary embodiment will be described with reference the flowcharts in FIGS. **3** and **4**.

<Interpretation of PDL Data>

FIG. **3** is a flowchart of PDL data interpretation processing executed by the PDL interpretation unit **120** and the interpretation result storage unit **130**.

In step S**201**, the PDL interpretation unit **120** receives PDL data including a plurality of PDL commands from the outside via the network I/F.

Next, in step S**202**, the PDL interpretation unit **120** interprets a single PDL command included in the PDL data received in step S**201**. Namely, the PDL interpretation unit **120** interprets the PDL data per PDL command.

Next, in step S**203**, the PDL interpretation unit **120** determines whether the PDL command interpreted in step S**202** specifies the end of a print job. If the PDL command specifies the end of a job (YES in step S**203**), the PDL interpretation unit **120** ends the operation.

If the PDL command does not specify the end of a job (NO in step S**203**), the operation proceeds to step S**204**. In step S**204**, the PDL interpretation unit **120** determines whether the PDL command interpreted in step S**202** specifies a page break (end).

If the PDL command specifies a page break (YES in step S**204**), the PDL interpretation unit **120** notifies the DL generation unit **150** that a single page of PDL command has been

interpreted (page end notification), via the signal line connecting the PDL interpretation unit **120** and the DL generation unit **150** in FIG. **1**. In addition, in step S**205**, the PDL interpretation unit **120** instructs the rendering unit **170** to start rendering processing after the DL generation unit **150** completes DL generation processing, via the signal line connecting the PDL interpretation unit **120** and the rendering unit **170** in FIG. **1**. As a result, the rendering unit **170** generates a bitmap image from the generated one page of DL. Next, the operation returns to step S**202**, and the PDL interpretation unit **120** starts interpreting the next PDL command included in the PDL data.

If the PDL command is not a command specifying a page break but is a rendering command (NO in step S**204**), the operation proceeds to step S**206**. In step S**206**, the PDL interpretation unit **120** stores the interpretation result of the rendering command in the interpretation result storage unit **130**. In this step, the PDL interpretation unit **120** accesses a certain memory address in the memory space in the interpretation result storage unit **130** and sequentially overwrites an old interpretation result with the interpretation result of the rendering command. In this way, the PDL interpretation unit **120** stores the interpretation result in the interpretation result storage unit **130**.

Next, in step S**207**, the PDL interpretation unit **120** suspends (stops) the interpretation of the PDL data.

Next, in step S**210**, the PDL interpretation unit **120** causes the interpretation result storage unit **130** to copy the interpretation result stored therein and to store the copy in the buffer **143**. The copy processing by the interpretation result storage unit **130** will be described below with reference to FIG. **5**. When the above copying is completed, the interpretation result storage unit **130** notifies the DL generation unit **150** that the interpretation result has been copied, via the signal line connecting the interpretation result storage unit **130** and the DL generation unit **150** in FIG. **1**. In addition, the interpretation result storage unit **130** sends an instruction to resume the interpretation of the PDL data to the PDL interpretation unit **120**, via the signal line connecting the interpretation result storage unit **130** and the PDL interpretation unit **120** in FIG. **1**.

In step S**211**, the PDL interpretation unit **120** receives the instruction for resumption of the interpretation of the PDL data from the interpretation result storage unit **130** and resumes the interpretation of the PDL data. Next, the operation returns to step S**202**, and the PDL interpretation unit **120** starts interpretation of the next PDL command.

In parallel with the above processing flow, the DL generation unit **150** asynchronously generates a DL from the copy of the interpretation result stored in the buffer **143**.

<Copy of Interpretation Result>

As illustrated in FIG. **5**, if an interpretation result includes an address indication pointer, the processing for copying the interpretation result of the rendering command includes processing for changing a memory address indicated by the pointer. Such processing for changing a memory address requires time. Next, the processing for changing the memory address will be described.

There are cases where the data structure of an interpretation result stored in the interpretation result storage unit **130** is a link structure including pointers for indicating addresses in the data. For example, as in the Bezier curve in FIG. **2**, a case will be considered where an interpretation result is data representing a plurality of lines, and data representing each line includes a pointer indicating a memory address of data representing another line. When attention is confined to data **1** and data **2** representing two respective lines, for example, as illustrated in FIG. **5**, in order to refer to data **2**, data **1** has a pointer P indicating memory address A1 of data **2** in the memory space in the interpretation result storage unit **130**.

If an interpretation result has such data structure, the following processing is executed in the interpretation result copy processing. A value of data **1** and a value of data **2** are copied in the memory space in the buffer **143**, and the memory address indicated by the pointer of data **1** is changed to memory address A2 of data **2** in the memory space in the buffer **143**. A longer link structure causes larger load on the copy processing. Namely, more time is required for the copy processing. For example, many rendering commands for curves have such data structures requiring more time for the copy processing. Since the interpretation result of a rendering command for a curve results in a plurality of simple lines, processing for generating a DL from each line requires only small load. Thus, the DL generation processing does not require much time.

Next, the DL generation processing to be executed asynchronously will be described.

<Generation of DL>

FIG. **4** is a flowchart of DL generation processing by the DL generation unit **150**.

When the DL generation unit **150** receives a notification from the PDL interpretation unit **120** in step S**205** or from the interpretation result storage unit **130** in step S**210**, in step S**301**, the DL generation unit **150** determines whether an interpretation result that has not been processed by the DL generation unit **150** is stored in the buffer **143**.

If an unprocessed interpretation result is stored (YES in step S**301**), the operation proceeds to step S**302**. In step S**302**, if a plurality of unprocessed interpretation results is stored, the DL generation unit **150** generates DLs one by one from the unprocessed interpretation results stored in the buffer **143** in the order that the interpretation results were stored in the buffer **143**. The DL generation unit **150** stores the DLs one by one in the order that the DLs have been generated in a DL storage unit (not illustrated). The DL generation unit **150** receives the next unprocessed interpretation result after generating a DL from a single unprocessed interpretation result.

After generating a DL from a single interpretation result, in step S**303**, the DL generation unit **150** deletes the interpretation result from the buffer **143**.

These steps S**301** to S**303** are repeated until all the unprocessed interpretation results are deleted from the buffer **143**. If no unprocessed interpretation result is stored in the buffer **143** (NO in step S**301**), the operation proceeds to step S**304**. In step S**304**, the DL generation unit **150** determines whether the DL generation unit **150** has received a notification from the PDL interpretation unit **120** in step S**205** (page end notification). If the DL generation unit **150** has not received the page end notification (NO in step S**304**), according to the present exemplary embodiment, it is assumed that the DL generation unit **150** has received a notification of completion of copying the interpretation result in step S**205**. Thus, the DL generation unit **150** ends the operation. If the DL generation unit **150** determines the reception of the page end notification (YES in step S**304**), the operation proceeds to step S**305**. In step S**305**, the DL generation unit **150** notifies the rendering unit **170** of completion of generation of one page of DL and sequentially transmits one page of DL stored in the DL storage unit (not illustrated) to the rendering unit **170**.

As described above, the printer controller according to the first exemplary embodiment causes the PDL interpretation unit **120** to analyze PDL commands one by one included in PDL data and to store an interpretation result per command in the interpretation result storage unit **130**. When an interpre-

tation result corresponding to a single command is stored in the interpretation result storage unit **130**, the interpretation result is copied and stored in the buffer **143**. Next, the PDL interpretation unit **120** analyzes the next PDL command, and in parallel to this operation, the DL generation unit **150** generates a DL from the copy of the interpretation result stored in the buffer **143**. Namely, the PDL data interpretation processing by the PDL interpretation unit **120** and the DL generation processing by the DL generation unit **150** are executed independently and asynchronously.

As described above, the printer controller according to the present exemplary embodiment copies an interpretation result in a buffer. In this way, since delay in the DL generation processing does not delay the PDL data interpretation processing, the PDL data interpretation processing can be executed efficiently.

In the printer controller according to the first exemplary embodiment, a copy of a PDL command interpretation result is stored in the buffer **143**. However, in a printer controller according to a second exemplary embodiment, whether to make a copy of a PDL command interpretation result in the buffer **143** is determined and a copy of the interpretation result is made on the basis of the determination. Reasons why these operations are executed will be described below.

When an interpretation result includes an address indication pointer, processing for copying a PDL command interpretation result, particularly a rendering command interpretation result, includes processing for changing the memory address indicated by the pointer. This memory address change processing requires time as described with reference to FIG. **5**. Such data configuration requires much time for copy processing, and as a result, an overall processing efficiency may be deteriorated. Thus, if such data structure is present, copy processing can be omitted.

In contrast to these rendering commands, for example, an interpretation result of a font rendering command is an index number specifying a font glyph (shape). Thus, since no pointer needs to be changed, processing for copying the interpretation result requires small load. However, when a DL is generated from the interpretation result, since processing for extracting the contour of the glyph (the contour of the object) is executed, processing for generating a DL from the interpretation result requires large load.

For the reason described above, the printer controller according to the present exemplary embodiment determines whether to execute the interpretation result copy processing on the basis of the amount of the load required for the copy processing.

<Configuration of Printer Controller According to Second Exemplary Embodiment>

The printer controller according to the present exemplary embodiment differs from the printer controller according to the first exemplary embodiment in that the PDL interpretation unit **120** determines whether to copy a PDL data interpretation result, and in that the interpretation result is copied in accordance with the determination.

The PDL interpretation unit **120** according to the present exemplary embodiment executes processing of a flowchart illustrated in FIG. **6**.

Other units are the same as those according to the first exemplary embodiment, unless otherwise described.

<Operation of Printer Controller>

An operation of the printer controller according to the second exemplary embodiment, particularly an operation of the PDL interpretation unit **120**, will be described with reference to the flowchart in FIG. **6**.

<Interpretation of PDL Data>

FIG. **6** is a flowchart illustrating PDL data interpretation processing executed by the PDL interpretation unit **120** and the interpretation result storage unit **130**.

Steps S**601** to S**607** are the same as steps S**201** to S**207**.

In step S**608**, the interpretation result storage unit **130** determines whether to copy the interpretation result stored in the interpretation result storage unit **130** in the buffer **143**. The determination method will be described below with reference to FIG. **7**.

In step S**608**, if the interpretation result storage unit **130** determines that the interpretation result storage unit **130** does not copy the interpretation result (NO in step S**608**), the interpretation result storage unit **130** causes the DL generation unit **150** to execute the flowchart illustrated in FIG. **4**. In step S**609**, the interpretation result storage unit **130** causes the DL generation unit **150** to generate a DL from the interpretation result stored in the interpretation result storage unit **130**. More specifically, the interpretation result storage unit **130** executes the following processing.

The interpretation result storage unit **130** determines whether all the interpretation results stored in the buffer **143** have been processed by the DL generation unit **150** on the basis of the number of interpretation results stored in the buffer **143**. Namely, if no interpretation result is stored in the buffer **143**, the interpretation result storage unit **130** determines that the DL generation unit **150** has processed all the interpretation results stored in the buffer **143**. The interpretation result storage unit **130** determines whether there is no unprocessed interpretation result in the buffer **143** at predetermined time intervals. If the interpretation result storage unit **130** determines that all the interpretation results stored in the buffer **143** have been processed, the interpretation result storage unit **130** causes the DL generation unit **150** to generate a DL from the interpretation result stored in the interpretation result storage unit **130**. The interpretation result storage unit **130** notifies this DL generation instruction of the DL generation unit **150** via the signal line connecting the interpretation result storage unit **130** and the DL generation unit **150** in FIG. **1**. Accordingly, the DL generation unit **150** generates a DL from the interpretation result stored in the interpretation result storage unit **130**. When completing the generation of a DL, the DL generation unit **150** notifies the interpretation result storage unit **130** of completion of generation of the DL. Next, when notified of completion of generation of the DL by the DL generation unit **150**, the interpretation result storage unit **130** sends an instruction to resume the interpretation of the PDL data, to the PDL interpretation unit **120**.

Next, the operation proceeds to step S**611**. Since the interpretation result in the interpretation result storage unit **130** according to the present exemplary embodiment is directly accessed by the DL generation unit **150**, the interpretation result storage unit **130** can be considered as a storage unit shared by the PDL interpretation unit **120** and the DL generation unit **150**.

In step S**608**, if the interpretation result storage unit **130** determines to copy the interpretation result, the operation proceeds to step S**610**. In step S**610**, the PDL interpretation unit **120** causes the interpretation result storage unit **130** to copy the interpretation result stored in the interpretation result storage unit **130** and to store the copy in the buffer **143**. The copy processing is the same as that described above with reference to FIG. **5**. This copy processing executed by the interpretation result storage unit **130** will be described below with reference to FIG. **5**. After making the copy, the interpretation result storage unit **130** notifies the DL generation unit

150 of completion of copying the interpretation result via the signal line connecting the interpretation result storage unit 130 and the DL generation unit 150 in FIG. 1. In addition, the interpretation result storage unit 130 sends an instruction to resume the interpretation of the PDL data, to the PDL interpretation unit 120 via the signal line connecting the interpretation result storage unit 130 and the PDL interpretation unit 120 FIG. 1. Next, the operation proceeds to step S611.

In step S611, the PDL interpretation unit 120 receives the instruction to resume the interpretation of the PDL data from the interpretation result storage unit 130 and resumes the interpretation of the PDL data. Next, the operation returns to step S202, and the PDL interpretation unit 120 starts interpreting the next PDL command.

<Determination of Whether to Copy PDL Interpretation Result in Buffer 143>

Determination processing in step S608 executed by the interpretation result storage unit 130 will be described with reference to flowcharts in FIGS. 7 and 8.

First, the purpose of the determination processing will be described with reference to FIG. 8.

FIG. 8A illustrates an operation of determining whether to copy an interpretation result stored in the interpretation result storage unit 130 when the buffer 143 stores no unprocessed interpretation result.

The operation in FIG. 8A uses processing load Tc required for processing of the DL generation unit 150 to generate a DL directly from the interpretation result stored in the interpretation result storage unit 130. In addition, the operation uses processing load Td required for processing for copying the interpretation result stored in the interpretation result storage unit 130 in the buffer 143. Larger processing load requires more processing time. As illustrated in FIG. 8A, if no unprocessed interpretation result is stored in the buffer 143, there are two choices for how the interpretation result stored in the interpretation result storage unit 130 is processed. In one choice, the interpretation result stored in the interpretation result storage unit 130 is copied in the buffer 143 (copy processing). In the other choice, instead of copying the interpretation result stored in the interpretation result storage unit 130 in the buffer 143, a DL is directly generated from the interpretation result (DL generation processing). Since it is desirable that the PDL interpretation unit 120 interpret the next PDL command as soon as possible, the user may select the copy processing or the DL generation processing that can be completed sooner than another processing. Thus, in the case of FIG. 8A, the processing load Tc and the processing load Td are compared with each other, and the processing requiring the smaller processing load is executed.

In contrast, FIG. 8B illustrates an operation of determining whether to copy an interpretation result stored in the interpretation result storage unit 130 when the buffer 143 stores unprocessed interpretation results.

Processing load Td illustrated in FIG. 8B is the same as that illustrated in FIG. 8A. The operation in FIG. 8B uses processing load Tr required for generating DLs from all the unprocessed interpretation results stored in the buffer 143, as will be described below with FIG. 7. Larger processing load requires more processing time. As illustrated in FIG. 8B, if the buffer 143 stores unprocessed interpretation results, there are two choices for how the interpretation results stored in the interpretation result storage unit 130 are processed. In one choice, the interpretation results stored in the interpretation result storage unit 130 are copied in the buffer 143 (copy processing). In the other choice, after DLs are generated from the unprocessed interpretation results stored in the buffer 143, a DL is directly generated from the interpretation result stored in the interpretation result storage unit 130, instead of copying the interpretation result in the buffer 143 (DL generation processing). When unprocessed interpretation results are stored in the buffer 143, delay is caused in the DL generation processing. Thus, it is desirable that this delay be eliminated as soon as possible. Thus, the user may select the copy processing or the DL generation processing that can be completed sooner than another processing needs to be selected. Thus, in the case of FIG. 8B, the processing load Tr and the processing load Td are compared with each other, and the processing requiring the smaller processing load is executed.

The determination processing based on the processing load will be described with reference to a flowchart in FIG. 7.

First, in step S401, the interpretation result storage unit 130 estimates load (processing cost) required for copying an interpretation result stored in the interpretation result storage unit 130 on the basis of the interpretation result. For example, the interpretation result storage unit 130 calculates the load as a numerical value on the basis of a data size of the interpretation result stored in the interpretation result storage unit 130 or a load coefficient (value) set for each type of rendering command or each type of rendering object created on the basis of the interpretation result. Larger load tends to require more time for copying the interpretation result in the buffer 143. Thus, in other words, the interpretation result storage unit 130 indirectly estimates the processing time.

Generally, if the interpretation result has a larger data size, larger load is required for the copy processing. However, the load of the copy processing can also be increased by other factors. More specifically, for example, many rendering commands specifying Bezier curves such as the one illustrated in FIG. 2 are used to render a curve having a small curvature. In such cases, the interpretation result has a link structure. Thus, a larger load coefficient is set for a rendering command specifying a Bezier curve than a load coefficient for a straight line rendering command according to which an interpretation result that does not have a link structure is generated. In contrast, a relatively small load coefficient is set for a rendering command resulting in copying of a simple interpretation result, such as copying an index number specifying the glyph of a font rendering command.

Next, in step S402, the interpretation result storage unit 130 checks a number of interpretation results stored in the buffer 143 that have not been processed by the DL generation unit 150.

If no unprocessed interpretation result is stored, namely, if the number determined in step S402 is 0 (YES in step S402), the operation proceeds to step S403. In step S403, the interpretation result storage unit 130 estimates the load required by the DL generation unit 150 in generating a DL by processing the interpretation result stored in the interpretation result storage unit 130. Namely, the interpretation result storage unit 130 calculates a processing cost required when the DL generation unit 150 generates a DL from this interpretation result instead of from a copy of this interpretation result. For example, the interpretation result storage unit 130 calculates the load as a numerical value on the basis of a (value) different from the load calculated in step S401. The different load coefficient is predetermined according to the data size of the interpretation result stored in the buffer 143, or according to each type of rendering object created on the basis of the interpretation result. More specifically, in the case of a rendering command for a curve having a small curvature or a rendering command for a dashed line or shading, a relatively short time is required to generate a DL. A smaller load coefficient (value) is set for such a rendering command than those for other rendering commands. In contrast, a larger load coef-

ficient (value) is set for a rendering command requiring a relatively long time to generate a DL from an interpretation result such as a font rendering command than those for other rendering commands.

Next, in step **S404**, the interpretation result storage unit **130** compares the load estimated in **S401** and the load estimated in **S403**. On the basis of this comparison, the interpretation result storage unit **130** determines which one of the two types of processing causes the larger delay. In this case, the delay corresponding to one type is the delay caused by the copying load estimated in step **S401**. Namely, the delay is caused by suspension of the interpretation of the PDL data between start of copying the interpretation result in the buffer **143** and completion of the copying. The delay corresponding to the other type is the delay caused by the processing load estimated in step **S403**, namely, the delay caused by suspension of the interpretation of the PDL data while the DL generation unit **150** is generating a DL by accessing the interpretation result storage unit **130**. Namely, the interpretation result storage unit **130** determines which takes more time before resumption of the interpretation of the PDL data, i.e., copying or not copying the interpretation result.

If the load estimated in step **S401** is larger than the load estimated in step **S403**, namely, if the load for copying the interpretation result is larger (YES in step **S404**), the operation proceeds to step **S405**. In step **S405**, the interpretation result storage unit **130** determines not to copy the interpretation result.

If the load estimated in step **S401** is equal to the load estimated in step **S403** or less, namely, if the load for copying the interpretation result is smaller (NO in step **S404**), the operation proceeds to step **S407**. In step **S407**, the interpretation result storage unit **130** determines to copy the interpretation result.

In step **S402**, if unprocessed interpretation results are still stored, the operation proceeds to step **S406**. In step **S406**, the interpretation result storage unit **130** estimates the load required by the DL generation unit **150** to process all the unprocessed interpretation results. Namely, the interpretation result storage unit **130** calculates a processing cost required for generating DLs from the unprocessed interpretation results that have already been copied in the buffer **143**. For example, the interpretation result storage unit **130** estimates a processing load value for each unprocessed interpretation result in the same method as that used in step **S403** and calculates the sum of the estimated values. In addition, from the above calculated sum, the interpretation result storage unit **130** subtracts a value of processing load processed by the DL generation unit **150** between when the DL generation unit **150** receives a copy of an interpretation result stored in the buffer **143** and when the interpretation result storage unit **130** calculates the processing load in step **S406**. Next, in step **S404**, the interpretation result storage unit **130** compares the load estimated in step **S401** and the load estimated in step **S406** to determine whether to copy the interpretation result.

On the basis of the comparison, the interpretation result storage unit **130** determines which one of the two types of processing causes the larger delay. In this case, the delay corresponding to one type is the delay caused by the copying load estimated in step **S401**. Namely, the delay is caused in a period after the DL generation unit **150** copies the interpretation result in the buffer **143** until a DL is generated from the interpretation result stored in the buffer **143**. The delay corresponding to the other type is the delay caused by the processing load estimated in step **S406**. Namely, the delay is caused in a period after when the DL generation unit **150** generates DLs from the unprocessed interpretation results by accessing the buffer **143** and until a DL is generated from the interpretation result stored in the interpretation result storage unit **130**. Namely, the interpretation result storage unit **130** determines which takes more time, i.e., copying or not copying the interpretation result to generate a DL from the interpretation result?.

<Mathematical Expression for Estimating Load>

For example, the following mathematical expression can be used to calculate the load Td in step **S401**.

$$Td=Kd\cdot S+Cd(\text{obj})$$

This mathematical expression includes coefficient Kd that depends on a hardware processing capability of the interpretation result storage unit **130**. The higher hardware processing capability the interpretation result storage unit **130** has, the smaller coefficient is set. In addition, the mathematical expression includes data size S of the interpretation result to be copied. In addition, the mathematical expression includes a constant value Cd(obj) that is defined for each obj indicating a rendering object type and that depends on a hardware processing capability of the interpretation result storage unit **130**. The higher hardware processing capability the interpretation result storage unit **130** has, the smaller constant value is set.

In addition, for example, the following mathematical expression can be used to calculate the load Tc in step **S403**.

$$Tc=Kc(\text{obj})\cdot S+Cc(\text{obj})$$

This mathematical expression includes coefficient Kc(obj) that is defined for each obj indicating a rendering object type and that depends on a hardware processing capability of the DL generation unit **150**. The higher hardware processing capability the DL generation unit **150** has, the smaller coefficient is set. In addition, the mathematical expression includes data size S of the interpretation result to be processed. In addition, the mathematical expression includes constant value Cc(obj) that is defined for each obj indicating a rendering object type and that depends on a hardware processing capability of the DL generation unit **150**. The higher processing capability the DL generation unit **150** has, the smaller coefficient is set. Next, the reason for defining coefficient Kc for each rendering will be described. For example, if the rendering object is image data, the data size S thereof tends to be larger than that of a rendering object of a different type. However, the load (time) required by the DL generation unit **150** to process image data is relatively small compared with that required for a rendering object of a different type. Thus, the load Tc can be estimated more accurately if a coefficient is defined which is multiplied by the data size of the rendering object to be processed for each rendering object.

In addition, for example, the following mathematical expression can be used to the calculate load Tr in step **S406**.

$$Tr=\Sigma Tc-Tf$$

This mathematical expression includes the sum ΣTc of the above load Tc of the unprocessed interpretation results copied in the buffer **143**. In addition, the mathematical expression includes time Tf that is a period from when the DL generation unit **150** starts processing an interpretation result being processed until when step **S406** is executed.

Namely, on the basis of information used for determining whether to copy the data (interpretation result) stored in the interpretation result storage unit **130** in the buffer **143**, the interpretation result storage unit **130** determines whether to copy the data in the buffer **143**. In this example, the information is the calculated values of the load amounts required for the respective types of processing.

As described above, from the interpretation result stored in the interpretation result storage unit **130**, the interpretation result storage unit **130** estimates the load required for the copy processing executed by the interpretation result storage unit **130** and the load required for the DL generation processing executed by the DL generation unit **150**. Thus, the load based on the type of the object to be rendered can be estimated accurately. In addition, if no unprocessed interpretation result is stored in the buffer **143**, the interpretation result storage unit **130** can determine whether to copy the interpretation result to start interpretation of the next PDL data as soon as possible.

In addition, according to the present exemplary embodiment, each load Td, Tc, and Tr is defined by a single expression, irrespective of the type of the object to be rendered. However, for example, an expression for estimating each load may be defined per rendering object type.

The estimated load Td corresponds to the time required for copying the interpretation result stored in the interpretation result storage unit **130** in the buffer **143**. In other words, the load Td estimated when no unprocessed interpretation result is stored in the buffer **143** corresponds to the delay time caused by execution of the copy processing until the next PDL command in the PDL data is interpreted.

The load Tc estimated when no unprocessed interpretation result is stored in the buffer **143** corresponds to the time required for generating a DL directly from the interpretation result stored in the interpretation result storage unit **130**. In other words, the load Tc corresponds to the delay time caused by directly executing the DL generation processing until the interpretation of the next PDL command in the PDL data is resumed.

If no unprocessed interpretation result is stored in the buffer **143**, the load Td and the load Tc corresponding to these two types of delay time are compared with each other, and the processing causing the less delay is selected. Thus, when no unprocessed interpretation result is stored in the buffer **143**, the PDL interpretation unit **120** can quickly resume the PDL data interpretation processing.

The load Td estimated when unprocessed interpretation results are still stored in the buffer **143** corresponds to the shortest delay time caused by execution of the copy processing at least until generation of a DL from an interpretation result copied in the buffer **143** is started.

In addition the load Tr estimated when unprocessed interpretation results are still stored in the buffer **143** corresponds to the time required until generation of a DL from an unprocessed interpretation result stored in the buffer **143** is completed. In other words, the load Tr corresponds to the delay time caused until generation of a DL directly from the interpretation result stored in the interpretation result storage unit **130** is started.

If unprocessed interpretation results are stored in the buffer **143**, the load Td and the load Tr corresponding to these two types of delay time are compared with each other, and the processing requiring less delay is selected. Thus, when unprocessed interpretation results are stored in the buffer **143**, the DL generation unit **150** can quickly start the DL generation processing. The sooner the generation of a DL is started, the sooner the generation of the DL is completed. Namely, the DL generation unit **150** can quickly complete generation of the DL.

In the above present exemplary embodiment, the interpretation result storage unit **130** determines whether to execute the interpretation result copy processing by calculating and comparing the processing load Td, Tc, and Tr. However, the determination may be made on the basis of another method.

For example, the determination may be made only on the basis of the processing cost (load Td) required for the interpretation result copy processing. In such a case, if the load Td exceeds a predetermined threshold, the PDL interpretation unit **120** controls the interpretation result storage unit **130** not to execute the copy processing and the DL generation unit **150** to generate a DL. In contrast, if the load Td is the predetermined threshold or less, the PDL interpretation unit **120** controls the interpretation result storage unit **130** to execute the copy processing and the DL generation unit **150** to generate a DL.

Alternatively, for example, the determination may be made only on the basis of the processing cost (load Tc) required for generating a DL from an interpretation result. In such a case, if the load Tc exceeds a predetermined threshold, the PDL interpretation unit **120** controls the interpretation result storage unit **130** to execute the copy processing and the DL generation unit **150** to generate a DL. In contrast, if the load Tc is the predetermined threshold or less, the PDL interpretation unit **120** controls the interpretation result storage unit **130** not to execute the copy processing and the DL generation unit **150** to generate a DL.

Alternatively, for example, the determination may be made only on the basis of the processing cost (load Tr) required for generating a DL from an unprocessed interpretation result stored in the buffer **143**. In such a case, if the load Tr exceeds a predetermined threshold, the PDL interpretation unit **120** controls the interpretation result storage unit **130** to execute the copy processing and the DL generation unit **150** to generate a DL. In contrast, if the load Tr is the predetermined threshold or less, the PDL interpretation unit **120** controls the interpretation result storage unit **130** not to execute the copy processing and the DL generation unit **150** to generate a DL.

Alternatively, for example, whether to copy an interpretation result may be determined as follows, without calculating each of the processing costs (loads Td, Tc, and Tr) described in the present exemplary embodiment. If the interpretation result stored in the interpretation result storage unit **130** has a data size that exceeds a predetermined threshold, the PDL interpretation unit **120** controls the interpretation result storage unit **130** not to execute the copy processing and the DL generation unit **150** to generate a DL. In contrast, if the interpretation result has a data size that corresponds to the predetermined threshold or less, the PDL interpretation unit **120** controls the interpretation result storage unit **130** to execute the copy processing and the DL generation unit **150** to generate a DL. In such a case, the predetermined threshold is used as the information for determining whether to copy the interpretation result.

Alternatively, the determination may be made on the basis of the type of the rendering command or the type of the rendering object to be created in accordance with the interpretation result. In such a case, a table is used in which certain types of rendering commands or rendering objects among the rendering command types or the rendering object types are described. If a rendering command matches the table (if the type of the rendering command matches a certain type), the PDL interpretation unit **120** controls the interpretation result storage unit **130** not to execute the copy processing and the DL generation unit **150** to generate a DL. In contrast, if the interpretation result does not match the table, the PDL interpretation unit **120** controls the interpretation result storage unit **130** not to execute the copy processing and the DL generation unit **150** to generate a DL. In such a case, the table is used as the information for determining whether to copy the interpretation result. For example, when this table includes a shading rendering command, if the rendering command is a

font rendering command, the interpretation result storage unit **130** executes the interpretation result copy processing. If the rendering command is a shading rendering command, the interpretation result storage unit **130** does not execute the interpretation result copy processing.

Other Exemplary Embodiments

While the interpretation result storage unit **130** and the buffer **143** are configured on different hardware modules in the printer controllers according to the above exemplary embodiments, the interpretation result storage unit **130** and the buffer **143** may be configured on a single hardware module. In such a case, a single memory of the hardware module, such as a random access memory (RAM), can be configured to function as a memory having a fixed size storage area included in the interpretation result storage unit **130** and a memory having a fixed-size storage area included in the buffer **143**. This is one of the other exemplary embodiments.

Other exemplary embodiments will be described. In the printer controllers according to exemplary embodiments, each of the processing for interpreting PDL data, the processing for copying an interpretation result, and the processing for generation a DL from the interpretation result is executed by an independent and dedicated hardware module. However, general-purpose arithmetic units such as central processing units (CPUs) may be allowed to execute the same processing as the processing executed by PDL interpretation unit **120**, the interpretation result storage unit **130**, the buffer **143**, and the DL generation unit **150** according to the above exemplary embodiments.

For example, assuming that a printer controller has a read-only memory (ROM), a RAM, and two CPUs, one (CPU1) of the CPUs is configured to execute the processing of the PDL interpretation unit **120**, the interpretation result storage unit **130**, and the buffer **143**. While the CPU1 is executing the above processing, another CPU (CPU2) is configured to execute the processing of the DL generation unit **150**. During the processing, the CPU1 reads a program for executing the processing of the PDL interpretation unit **120**, the interpretation result storage unit **130**, and the buffer **143** from the ROM and executes the program. In addition, the CPU2 reads a program for executing the processing of the DL generation unit **150** from the ROM and executes the program. In such a case, the RAM functions as a storage area for each of the interpretation result storage unit **130** and the buffer **143**. The storage area functioning as the interpretation result storage unit **130** and the storage area functioning as the buffer **143** do not overlap with each other.

In addition, this processing may be executed on the basis of threads per PDL command. In this way, it is possible to configure a printer controller such that, while the CPU1 is interpreting a PDL command, the CPU2 can generate a DL from another interpretation result. Since the processing may be executed on the basis of threads, it is possible to configure the printer controller such that, while the CPU2 is interpreting a PDL command, the CPU1 can generate a DL from another interpretation result.

OTHER EMBODIMENTS

Embodiments of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions recorded on a storage medium (e.g., non-transitory computer-readable storage medium) to perform the functions of one or more of the above-described embodiment(s) of the present invention, and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more of a central processing unit (CPU), micro processing unit (MPU), or other circuitry, and may include a network of separate computers or separate computer processors. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™, a flash memory device, a memory card, and the like.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2013-151655 filed Jul. 22, 2013, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A display list generation apparatus comprising:

an interpretation unit configured to interpret page description language (PDL) data and store an interpretation result of the PDL data in a first storage unit;

a copying unit configured to copy the interpretation result stored in the first storage unit, into a second storage unit in a case where a data size of the interpretation result does not exceed a predetermined threshold, and not to copy the interpretation result stored in the first storage unit, into the second storage unit in a case where a data size of the interpretation result exceeds the predetermined threshold; and

a generation unit configured to generate a display list from the interpretation result stored in the first storage unit in a case where a data size of the interpretation result exceeds the predetermined threshold and generate a display list from the copy of the interpretation result stored in the second storage unit in a case where the data size of the interpretation result does not exceed the predetermined threshold.

2. The display list generation apparatus according to claim **1**, wherein, in a case where data included in the interpretation result stored in the first storage unit is a pointer indicating a memory address in the first storage unit in which other data included in the interpretation result is stored, when the interpretation unit executes the copying, the interpretation unit changes the memory address indicated by the pointer to a memory address in the second storage unit in which the other data is stored.

3. The display list generation apparatus according to claim **1**, wherein the interpretation unit suspends the interpretation of the PDL data and the storage of the interpretation result in the first storage unit during the processing executed by the interpretation unit.

4. The display list generation apparatus according to claim **1**, wherein the interpretation of the PDL data by the interpretation unit and the generation of the display list by the generation unit are executed asynchronously.

5. The display list generation apparatus according to claim **1**, wherein the interpretation unit is a first central processing unit (CPU), the generation unit is a second CPU different

from the first CPU, and the interpretation unit interprets the PDL data while the generation unit is generating the display list.

6. The display list generation apparatus according to claim **1**, wherein the interpretation unit interprets the PDL data per PDL command and stores an acquired interpretation result in the first storage unit by overwriting an older interpretation result per PDL command in a certain memory address in the first storage unit.

7. The display list generation apparatus according to claim **1**, further comprising:

a rendering unit configured to render a bitmap image from the display list generated by the generation unit,

wherein the interpretation unit can interpret PDL data of a plurality of PDL types,

wherein the interpretation result is data in a format that does not depend on a PDL type, and

wherein the display list is data in a format that can be processed by the rendering unit.

8. The display list generation apparatus according to claim **1**, further comprising:

a determination unit configured to determine whether the copying unit executes the copying on the basis of the interpretation result stored in the first storage unit,

wherein, in a case where the determination unit determines that the copying unit does not execute the copying, the copying unit does not copy the interpretation result stored in the first storage unit and the generation unit generates a display list from the interpretation result stored in the first storage unit, and

wherein, in a case where the determination unit determines that the copying unit executes the copying, the copying unit copies the interpretation result stored in the first storage unit and stores the copy of the interpretation result in the second storage unit and the generation unit generates a display list from the copy of the interpretation result stored in the second storage unit.

9. The display list generation apparatus according to claim **8**, wherein, in a case where the determination unit determines that the copying unit does not execute the copying, the interpretation unit suspends the interpretation of the PDL data and the storage of the interpretation result in the first storage unit until the generation unit completes generation of a display list from the interpretation result stored in the first storage unit.

10. The display list generation apparatus according to claim **8**, wherein the determination unit determines whether the copying unit executes the copying on the basis of a data size or type of the interpretation result stored in the first storage unit.

11. The display list generation apparatus according to claim **10**,

wherein, in a case where the data size of the interpretation result stored in the first storage unit exceeds the predetermined threshold, the determination unit determines that the copying unit does not copy the interpretation result stored in the first storage unit, and

wherein, in a case where the data size of the interpretation result stored in the first storage unit does not exceed the predetermined threshold, the determination unit determines that the copying unit copies the interpretation result stored in the first storage unit.

12. The display list generation apparatus according to claim **10**,

wherein, in a case where the data type of the interpretation result stored in the first storage unit is not a predetermined type, the determination unit determines that the copying unit executes the copying, and

wherein, in a case where the data type of the interpretation result stored in the first storage unit is the predetermined type, the determination unit determines that the copying unit does not execute the copying.

13. The display list generation apparatus according to claim **8**, wherein the determination unit comprises:

a first unit configured to calculate load required for the copying executed by the copying unit on the basis of at least one of a data size and a data type of the interpretation result stored in the first storage unit;

a second unit configured to calculate load required for generation of a display list executed by the generation unit from the interpretation result stored in the first storage unit on the basis of at least one of the data size and the data type of the interpretation result stored in the first storage unit; and

a third unit configured to determine that the copying unit does not execute the copying in a case where the calculated load required for the copying is larger than the calculated load required for the generation of the display list and determine that the copying unit executes the copying in a case where the calculated load required for the copying is not larger than the calculated load required for the generation of the display list.

14. The display list generation apparatus according to claim **13**, further comprising:

a fourth unit configured to calculate load required for the generation of the display list by the generation unit, from a copy of the interpretation result stored in the second storage unit on the basis of at least one of a data size and a data type of the copy of the interpretation result stored in the second storage unit; and

a fifth unit configured to determine whether a copy of an interpretation result is stored in the second storage unit,

wherein the determination unit determines, in a case where the fifth unit determines that no copy of the interpretation result is stored in the second storage unit, whether the copying unit executes the copying on the basis of the calculated load required for the copying and the calculated load required for the generation of the display list by the generation unit, from the interpretation result stored in the first storage unit,

wherein, in a case where the determination unit determines that a copy of the interpretation result is stored in the second storage unit and in a case where the calculated load required for the copying is larger than the calculated load required for the generation of the display list by the generation unit, from the copy of the interpretation result stored in the second storage unit, the determination unit determines that the copying unit does not execute the copying, and

wherein, in a case where the calculated load for the copying is not larger than the calculated load required for the generation of the display list by the generation unit, from the copy of the interpretation result stored in the second storage unit, the determination unit determines that the copying unit executes the copying.

15. The display list generation apparatus according to claim **1**, wherein the first storage unit and the second storage unit are different storage areas in a single storage unit.

16. The display list generation apparatus according to claim **1**, wherein a PDL command included in the PDL data is a rendering command specifying a curve, an interpretation result of the rendering command is data of a plurality of lines approximately representing the curve, and lines connected to each other are linked with each other, and wherein a display list acquired from the interpretation result of the rendering

command is data of a plurality of objects representing a counter of the plurality of lines.

17. A display list generation method comprising:

interpreting page description language (PDL) data;

storing an interpretation result of the PDL data in a first storage unit;

generating, in a case where a data size of the interpretation result exceeds a predetermined threshold, a display list from the interpretation result stored in the first storage unit;

copying, in a case where the data size of the interpretation result does not exceed the predetermined threshold, the interpretation result stored in the first storage unit, into a second storage unit, and not to copy the interpretation result stored in the first storage unit, into the second storage unit in a case where a data size of the interpretation result exceeds the predetermined threshold;

and generating a display list from the copy of the interpretation result stored in the second storage unit.

18. A non-transitory computer readable medium storing a program which causes a computer to execute a display list generation method, the method comprising:

interpreting page description language (PDL) data;

storing an interpretation result of the PDL data in a first storage unit;

generating, in a case where a data size of the interpretation result exceeds a predetermined threshold, a display list from the interpretation result stored in the first storage unit;

copying, in a case where the data size of the interpretation result does not exceed the predetermined threshold, the interpretation result stored in the first storage unit, into a second storage unit, and not to copy the interpretation result stored in the first storage unit, into the second storage unit in a case where a data size of the interpretation result exceeds the predetermined threshold;

and generating a display list from the copy of the interpretation result stored in the second storage unit.

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